Tear film measurements in four different ethnic groups：Malay，Chinese，Indian and Nigerian

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马来、中国、印度和尼日利亚四个不同国家人群的泪膜测量分析

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摘要
目的：比较马来、中国、印度和尼日利亚 4 个不同人群的无创性泪膜破裂时间（NIBUT）、泪膜破裂时间（TBUT）、基础泪液分泌量（BTS）和眨眼频率。
方法：共纳入 120 例（男性 61 例，女性 59 例）年龄 20～39 岁健康受试者，其中 30 例马来人，30 例中国人，31 例印度人，29 例尼日利亚人。根据 McMonnies 调查问卷和临床检查，挑选了健康受试者。选取受试者右眼评估 NIBUT、TBUT、BTS，及眨眼频率。
结果：四组人群中 NIBUT、TBUT、BTS，及眨眼频率具有显著差异（$P=0.018，P=0.001，P=0.011，P=0.004$）。不同民族人群性别间 NIBUT、TBUT、BTS 和眨眼频率差异无统计学意义。相较于其他三组，印度人 NIBUT（10 ± 6s），TBUT（7 ± 5s）和 BTS（20 ± 20 mm）中位数较高，中国人 NIBUT（7.5 ± 4s）和 TBUT（4 ± 2s）中位数较低，马来人 BTS 为 9.5 ± 16mm。眨眼频率与 NIBUT、TBUT、BTS 间无显著相关（$r=-0.119，P=0.195$），（$r=-0.086，P=0.352$），（$r=-0.123，P=0.180$）。
结论：研究体现了四个不同国家人群间泪膜测量值的差异性。
关键词：无创泪膜破裂时间；泪膜破裂时间；基础泪液分泌；眨眼频率和种族特点

Abstract

• AIM：To compare the non-invasive tear film break-up time（NIBUT），tear break up time（TBUT），basal tear secretion（BTS）and blink rate in four ethnic groups：Malay，Chinese，Indian and Nigerian.

• METHODS：Totally 120 healthy（61 males and 59 females）subjects（without dry eye symptoms and ocular surface disorder）with the age 20 to 39 years were recruited；30 were Malays，30 were Chinese，31 were Indians and 29 were Nigerians. Based on McMonnies questionnaire and clinical examination，normal subjects were selected. NIBUT，TBUT，BTS were assessed in only one eye（right）of each subject and blink rate was also assessed.

• RESULTS：There was significant difference in the NIBUT，TBUT，BTS and blink rate among 4 different ethnic groups（$P=0.018$），（$P=0.001$），（$P=0.011$），and（$P=0.004$）respectively. No statistically significant difference of NIBUT，TBUT，BTS and blink rate was found between the genders among different ethnic groups. Indian had higher median for NIBUT（10 ± 6s），TBUT（7 ± 5s）and BTS（20 ± 20 mm）than others races. Chinese had lower median for NIBUT（7.5 ± 4s）and TBUT（4 ± 2s）while Malay had low BTS（9.5 ± 16 mm）among the groups. There was no significant correlation of blink rate with NIBUT，TBUT and BTS（$r=-0.119$，$P=0.195$），（$r=-0.086$，$P=0.352$），（$r=-0.123$，$P=0.180$）respectively.

• CONCLUSION：This study showed the variability in tear-film measurements values in four ethnic groups.

• KEYWORDS：non-invasive tear film break-up time；tear break-up time；basic tear secretion；blink rate and ethnicity

INTRODUCTION

Measurements of the stability and volume of tear film are important while assessing the ocular surface in cases of dry eye syndrome. Dry eye syndrome and tear film dysfunction are synonymous. Tear film dysfunction leads to ocular complications such as excessive tearing，conjunctival and corneal surface damage，and vision changes[1-2]. Therefore，the tear stability and volume is essential in assessing contact lens fitting，cataract and refractive surgery，and also to know the outcome of dry eye treatment[3-9]. The normal values of

tear stability and volume may differ in different ethnic groups. Differences in eyelid anatomy (e.g. palpebral aperture size and lid margin apposition against the ocular surface) between Asians and non-Asians may contribute to variability in tear film thickness and tear-film stability[10]. Studies suggesting wider palpebral aperture sizes and palpebral aperture width lead to more exposure and greater disruption in tear film[11-12]. There are separate reports on tear stability and tear volume in different ethnic groupsliving in different environments[13-20]. However, due to the difference in instrument designs and observational procedures, there are differences in tear film measurements. The purpose of this study was to determine the tear stability and tear volume in Chinese, Malay, Indian and Nigerian ethnic groups living in the same climate.

SUBJECTS AND METHODS

This was a prospective crosssectional study. A total of 120 subjects (age range 20 - 39 years) were recruited. The subjects were from 4 different ethnicities: 30 Malays, 30 Chinese, 31 Indians and 29 Nigerians. All the subjects were students, 3 ethnics groups: Malays, Chinese, and Indians were Malaysian whereas, Nigerians were from Nigeria, studying in Malaysia under same university. The study was carried out in the Optometry Clinic at Twintech International University College of Technology, Faculty of Optometry, Kuala Lumpur, Malaysia. Informed consent was obtained from all participants prior to any measurement. The study was conducted according to the tenets of Declaration of Helsinki.

The inclusion criteria set for this study was as follow: age between 20 to 39 years, currently not on any medication, not contact lens wearers, have no history of any ocular surgery, havehabitual visual acuity of 20/30 or better, have normal appearance of all corneal layers on slit lamp examination and with no corneal lesions. Individuals with autoimmune disorders, and females during pregnancy, menstruation, lactation, and hormone replacement therapy were excluded. Subjects having a history of dry eye and Mc - Monnies questionnaire score more than 14.5 were also excluded from this study to rule out dry eye[21].

Habitual visual acuity was measured using a Snellen chart. Tear film status was then evaluated. Blink rate was measured first. The number of blinks made per minute was recorded. Non-invasive tear film break-up time (NIBUT), tear break-up time (TBUT), basic tear secretion (BTS) were assessed in only one eye (right) of each subject.

The NIBUT test, which measures tear stability without the introduction of a foreign substance into the tear film[22], was assessed next by using a Shin-Nippon S0-21 keratometer. The subject was seated carefully and the keratometer well adjusted for the right eye with the mires in focus. The subject was asked to blink once and then refrain from blinking. A stopwatch was started after the last complete blink. At the first sign of any distortion of the mires, the stopwatch was stopped and the time noted. If the subject blinked between measurements, the test was repeated after several blinks. The time interval between the last blink and the first sign of mire distortion was recorded in seconds as the NIBUT. The test was repeated three times to increases the reliability and the average was then taken[14].

TBUT is the time needed for the appearance of dark spots of the tear film after blinking of the fluorescein treated eye[22]. For the measurement of TBUT, the upper eyelid of the right eye was slightly lifted and the fluorescein strip was then used to stain the tear film. The subject was asked to blink a few times for homogenous mixing of fluorescein in tear film. Then, the tear film was observed under cobalt - blue filter. The stopwatch was started after the last blink and the appearance of dry spots on the corneal surface was detected and recorded in seconds. An average of three readings was taken.

After resting for 10min, BTS was measured using Schirmers strips (Whatman no 41 filter paper, tear touch). A drop of tropical anaesthesic (0.5%, Alcaine) was instilled in the tested eye. After 2min, the Schirmers strip was placed at the lateral one third of the lower eyelid of the eye. The subject was asked to blink normally. After 5min, the strip was removed. The length of the wetted strip from the fold was measured.

All thesubjects were tested between 10 a.m.-12 p.m. at least after 2h of waking. Tear film measurements were performed in the same room to maintain a relatively constant temperature and humidity. Slit lamp biomicroscopy of the anterior segment (lids, cornea, and conjunctiva) was also performed. Meibomian gland dysfunction was recorded according to Efron grading scale. The grade 0-1 was considered as normal in this study[23].

Statistical Analysis　Statistical analyses were done by using SPSS version 16.0 statistical software and MS Excel 2007. Test of normality was performed by Kolmogorov-Smirnov test. The measurement variables were not normally distributed. Kruskal-Wallis test was performed among four different ethnic groups. Mann-Whitney test was performed between the ethnic groups and sex groups. To evaluate correlation between variables, Spearman correlation coefficient was used. A $P \leqslant 0.05$ was set for statistical significance.

RESULTS

A total of 120 subjects (mean: 23.07±2.69 years; range 20-39 years) were examined. There were 61 (50.8%) male and 59 (49.2%) female subjects. Thirty (25%) subjects were Malays, 30 (25%) were Chinese, 31 (25.8%) were Indians and 29 (24.2%) were Nigerians. There was no statistically significant difference in age among ethnic groups.

There was statistically significant difference in the NIBUT ($P = 0.018$), TBUT ($P = 0.001$), BTS ($P = 0.011$) and blink rate ($P = 0.004$) among ethnic groups (Table 1). Indians had the highest NIBUT, TBUT, and BTS whereas Chinese had the lowest mean NIBUT and TBUT (Table 1). The NIBUT, TBUT and BTS amongst Indians were significantly higher compared to Malays, and Chinese (Table 2). The blink rate for Malays was significantly higher than for Indians, Chinese and Nigerians (Table 2).

Table 1　Comparison of age and tear film measurements among ethnic groups　median±IQR

Variables	Total($n=120$)	Malay($n=30$)	Chinese($n=30$)	Indian($n=31$)	Nigerian($n=29$)	P
Age	23±3	23±2	23±1	23±2	22±4	0.093
Blink rate（blinks/min）	12±6	16±8	12±6	12±6	12±4	0.004
NIBUT（s）	8±4	8±4	7.5±4	10±6	8±4	0.018
TBUT（s）	5.3±4	5±3	4±2	7±5	6±4	0.001
Basic tear secreation（mm）	13±14	9.5±16	11.5±10	20±20	13±12	0.011

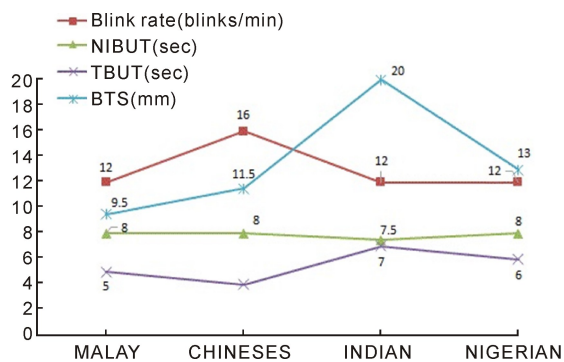NIBUT：non-invasive tear film break-up time；TBUT：Tear break-up time.

Figure 1　Median of blink rate，NIBUT，TBUT and BTS in ethnic groups.

Table 2　Comparison of tear film measurements between ethnic groups　　　　（P）

Groups	Variables	Chinese	Indian	Nigerian
Malay	Blink rate	0.02	0.03	0.001
	NIBUT	0.384	0.046	0.531
	TBUT	0.184	0.01	0.173
	Basic tear secretion	0.407	0.003	0.129
Indian	Blink rate	0.791	–	–
	NIBUT	0.002	–	–
	TBUT	0.001	–	–
	Basic tear secretion	0.01	–	–
Nigerian	Blink rate	0.214	0.106	–
	NIBUT	0.086	0.112	–
	TBUT	0.004	0.101	–
	Basic tear secreation	0.417	0.079	–

NIBUT：Non-invasive tear film break-up time；TBUT：Tear break-up time.

There was no statistically significant difference in age（$P=0.095$），blink rate（$P=0.881$），NIBUT（$P=0.114$），TBUT（$P=0.841$），and BTS（$P=0.348$）between genders（Table 3）. Furthermore，there was no significant difference of tear film measurements（blink rate，NIBUT，TBUT，and basic tear secretion）with gender in Malay，Chinese，Indian，and Nigerian.

Table 4 shows correlation between tear film variables，and age. The degree of association between NIBUT，TBUT and BTS was significant. There was，however，no significant correlation of blink rate with NIBUT，TBUT and BTS（$r=-0.119$，$P=0.195$），（$r=-0.086$，$P=0.352$），（$r=-0.123$，$P=0.180$）respectively.

DISCUSSION

Our results shown that Indian had highest tear film measurements

Table 3　Comparison of age and tear film measurements between genders

Parameters	Genders	Median±IQR	P
Age（y）	M(61)	23±2	0.095
	F(59)	23±2	
Blink rate（blinks/min）	M(61)	12±7	0.881
	F(59)	12±6	
NIBUT(s)	M(61)	9±4	0.114
	F(59)	8±5	
TBUT(s)	M(61)	5±4	0.841
	F(59)	6±4	
Basic tear secretion(mm)	M(61)	13±16	0.348
	F(59)	12±14	

（NIBUT：10s；TBUT：7s and BTS：20 mm）among studied groups. While Chinese had lowest median for NIBUT（7.5s），TBUT（4s）compared to the others ethnic. Furthermore，Malay had lowest median for BTS（9.5 mm）and highest for blink rate（16 blinks/min）. Between the genders，there was no statistically significant difference of tear film measurement values in Malay，Chinese，Indian and Nigerian.

Based on previous studies，humidity and temperature has been shown to affect the tear film stability[24-27]. Therefore，in the present study，all measurements were performed in same room to maintain a relatively constant temperature and humidity. Earlier studies have shown that there is a diurnal variation of the tear film[28-30]. Shen et al[28] have reported that the tear meniscus increased at eye opening，after overnight sleep，compared with before sleep. They also reported that the stability of the pre-corneal tear film varied over a single 12-hours period. Another study suggested that the tear stability is low early in the morning，and tends to rise to equilibrium level between 10：00 a.m. and 12 p.m.[29]. However，Srinivasan and colleagues showed no significant diurnal changes in the bare-eye tear film surface quality[30]. In order to avoid diurnal variations，the present study was performed between 10 a.m.-12 p.m. There is an influence of corneal hydration due to reduce in tear film evaporation within 2h of waking. Thus，tear film procedures were performed in present study after 2h of waking[31].

The present study showed that different ethnic groups had different tear stability. This is similar to some previous studies which show that there is variability in TBUT values in different ethnic groups[15,17]. The NIBUT，TBUT，and BTS of Indian ethnic group were significantly higher than Chinese，

Table 4　Correlation between study variables

Variables	BR	NIBUT	TBUT	BTS
Age	$r= -0.931$, $P=0.311$	$r= -0.015$, $P=0.872$	$r= -0.32$, $P=0.729$	$r= -0.54$, $P=0.556$
BR	–	$r= -0.119$, $P=0.195$	$r= -0.086$, $P=0.352$	$r= -0.123$, $P=0.180$
TBUT	–	$r=0.786$, $P=0.001$	–	$r=0.384$, $P=0.001$
NIBUT	–	–	–	$r=0.345$, $P=0.001$

NIBUT：Non-invasive tear film break-up time；TBUT：Tear break-up time；BTS：Basic tear secretion.

Table 5　Comparison of present study with previous studies based on ethnic groups

Studies	Malays		Chinese		Indian		Nigerian	
	TBUT (s)	NIBUT(s)	TBUT (s)	NIBUT(s)	TBUT (s)	NIBUT(s)	TBUT (s)	NIBUT(s)
Madugil et al[13]	–	–	–	–	13.87±4.76	–	–	–
Cho[14]	–	–	–	16±9.4	–	–	–	–
Patel et al[15]	–	–	–	9.8±3.90	–	16.4±6.9	–	11.8±5.9
Mohidin et al[16]	–	15.8±9.4	–	–	–	–	–	–
Jamaliah et al[17]	9.65±4.14	–	8.61±3.73	–	8.92±2.92	–	–	–
Amaechi et al[18]	–	–	–	–	–	–	15.2±3.1	15.3±3.0
Sharanjeet et al[19]	–	7.74±3.34	–	7.15±3.38	–	7.24±2.67	–	–
Presentstudy	5±3	8±4	4±2	7.5±4	7±5	10±6	6±4	8±4

NIBUT：Non-invasive tear film break-up time；TBUT：Tear break-up time.

Malay, and Nigerian in the present study. Patel et al[15] also reported similar findings in that the mean NIBUT of Indians was higher compared to Chinese and African while Chinese had lower value of NIBUT. Cho & Brown noted that the mean TBUT of Hong Kong-Chinese was approximately 8s and about 70% of Hong Kong-Chinese had TBUT's less than 10s[20]. Among Malaysian, present study showed Chinese had lower TBUT and NIBUT, also similar finding by Amaechi et al[18] and Sharanjeet-kaur et al[19] suggesting Chinese had lower TBUT and NIBUT respectively[18-19]. Studies reported morphological difference of periorbital features like palpebral aperture size and width in different ethnic groups[32-34]. Thus, it influences the tear film measurement[11-12]. Packiriswamy et al[32] reported the mean palpebral fissure height values in Malaysian both male (Indian 10.9 mm; Malay, 10 mm; Chinese 9.6 mm) and female (Indian 11.3 mm; Malay 1.70 mm; Chinese 10.3 mm). Interestingly, present study as well as previous studies suggested tear film stability increases with greater palpebral fissure dimension while comparing among the Malaysian ethnics groups[18-19,32-34].

This present study reportedno significant difference in blink rate, NIBUT, TBUT and BTS between males and females. This is also supported by earlier studies with similar results between the genders[15-16,18,20]. However, few reports showed the majority of dry-eye sufferers are women, and female gender has been identified as a risk factor for dry-eye development[35-36]. The difference in sex hormones that influences the anatomical and functional structures of the ocular surface, and tear film components[36-37].

Blink rate was not correlated with NIBUT, TBUT and BTS in this study. There are a number of factors that can alter blink rate and have a profound impact on the ocular surface. Multiple factors can contribute to changes in blink rate, for example, thickness of the lipid layer, rate of eye drying, humidity, temperature, pollutants and visual tasks[38-41]. Thus, although blink rate is fairly constant for any individual, it can be affected by external conditions.

Although, the results from the present study indicate that there are reduced values of TBUT and NIBUT compared to previous studies, the results are comparable within the ethnic groups (Table 5). Interestingly, there is wide variability in normal values of TBUT and NIBUT between previous studies and recent studies. The recent studies have reported that the values for TBUT and NIBUT were lesser compared to those from earlier studies. This reduction of values of TBUT and NIBUT in recent studies may be mainly due to environmental factors and other factors like different age population distribution, and methodology.

There are few limitations of this study. First, there was no record of temperature and humidity, even though all the examinations were performed in same room to control the changes in tear. Second, the differences in instrument designs and observation procedures could cause the discrepancies in measurement values of tear film while comparing with previous studies. A modified perimeter bowl instrument was used by Mohidin et al[16] and Cho[14] to measure the NIBUT. Patel et al[15] and Amaechi et al[18] had measured NIBUT by. keratometer whereas Sharanjeet-Kaur et al[19] used tearscope plus.

The study showed thattear film measurements are different in the 4 different ethnic groups (Malay, Chinese, Indian and Nigerian). Comparatively, Indians has highest tear film measurement values compared to other ethnic groups studied. The Chinese had lowest NIBUT and TBUT compared with the other ethnic groups. Therefore, the norm values for tear stability and tear volume should be established based on the ethnic distribution.

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